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1 A Case for Infrastructure Renewal with Accountability

1.1 INTRODUCTION

The main purpose of this book is to introduce the IPQMS (Integrated Planning and Quality Management System) and related case histories that represent autopsies or postmortems of projects. Experience shows that lessons learned from past costly mistakes and disasters are invaluable in achieving quality projects on time and on budget.^{1,2} This is the first book to show how to prepare guidelines and checklists for new programs or projects. The 20-year study demonstrated that the IPQMS can be adapted to programs and projects in different sectors. It can also be adapted to the growing trend for design-construction projects. The use of this system will be applied to rebuilding America's infrastructure (Chapter 10).

The economic and social well-being of a nation are directly related to the quality of its infrastructure and environment. The demise of past civilizations — Egyptian, Roman, Inca, and others — accelerated when they stopped maintaining and improving their public works. Unfortunately, the U.S. is now guilty of ignoring the inadequacy of its infrastructure. Indeed, this is happening despite the efforts of the Rebuild America Coalition, which was established in 1987.³

1.2 OUR DETERIORATING INFRASTRUCTURE

America is at a crossroads in its battle to maintain economic strength and quality of life. Both are jeopardized by the nation's apathy toward repairing and expanding our existing national infrastructure, and cleaning up the environment. Infrastructure covers highways, bridges, airports, water supply systems, wastewater treatment plants, solid waste disposal facilities, and public schools. It includes the need to provide clean air and water, and control disease. Thus, it is a basic need to sustain and further economic and social growth in all nations.

It is estimated that 60 percent of the nation's highways need work, ranging from repaving to major structural rehabilitation. According to the Federal Highway Administration⁴, ± 35 percent of the 575,000 highway bridges in the U.S. are structurally deficient or functionally obsolete. Some cities have water-main leaks that lose up to 30 percent of their water supply every day. Such widespread decline threatens to disable entire systems made unstable by delayed maintenance and stop-gap repairs. Conservatively, the loss of man hours and fuel because of detours and traffic congestion costs both industry and the public sector over \$30 billion each year, and the cost is increasing.³

In addition, nearly 31 percent of America's public schools were built before World War II. Thus, about a third of the country's 42 million school-children are trying to prepare for adult life in schools that lack proper heat, ventilation, and bathroom facilities.

Directly related to public health is the on-going pollution of our nation's lakes, rivers, streams, and bays. This is compounded by outbreaks of bacteria in municipal drinking water supply systems, such as the one that made 400,000 people sick in Milwaukee in 1993.³

Though much progress has been made since the Clean Water Act of 1972, the task requires constant attention. Much remains to be done. A profile of U.S. water resources includes the following:³

- More than 3.5 million miles of rivers and streams
- 62,000 square miles of lakes, ponds, and reservoirs
- 5,300 miles of Great Lakes shoreline
- 37,000 square miles of estuaries

As of 1992, states reported the following:

- 8 percent of rivers, 43 percent of lakes, and 13 percent of estuaries were contaminated with toxic chemicals
- Of the assessed rivers, 38 percent are polluted to the point where they fail to meet designated uses
- 44 percent of lakes, ponds, and reservoirs fail to meet designated uses
- 97 percent of the Great Lakes shoreline miles fail to meet designated uses

In addition to the foregoing, there is the problem of hazardous waste which impacts public health in all 50 states. The number of toxic waste sites has increased despite the efforts of the Environmental Protection Agency's Superfund Program. Public health problems were found to be worse with the official exposure of the nuclear weaponry research in 1992 — thousands of contaminated sites in 13 states.^{5,6} The nuclear weaponry resulted from secret bomb factories and represents a total collapse of ethics and accountability in our government and the defense contractors.

The foregoing infrastructure and related environmental problems are compounded by the serious problems in the U.S. construction industry. Our construction industry is one of the nation's largest single industries, and, unfortunately, it is also the most fragmented and least progressive.

Without continuous investment in infrastructure, a modern economy fails to grow. Our economic competitors are keenly aware of this. *All* of the major industrialized countries invest a higher percentage of gross domestic product in public works than the U.S. (Japan leads all of the G-7 countries. In 1992, its infrastructure investment was roughly triple that of the U.S. It also leads in productivity growth, about triple the rate of our country.) Rhetoric about laying the foundation for a better America rings hollow when we are last on the list of countries investing in their own economic future.

Infrastructure requires continuous attention. Federal, state, and local governments, under pressure to cut budgets, often delay maintenance and repair. This, of course, is not economical at all, but the most expensive form of underinvestment. Instead of leaving behind more than we found, our legacy to our children will be to break the unspoken promise of a better life, to pass on the debts we didn't pay and a diminished quality of life. It's not too late to make good on that promise, but as a nation we must act now. The necessary action must ensure optimization of dwindling resources to provide infrastructure rebuilding that is cost effective and high quality. This will require accountability! This will require the use of an integrated planning and quality management system such as the IPQMS.

1.3 STATUS OF THE ENVIRONMENT

Before the 1970s, few people worried about hazardous waste as long as they were not affected by the harmful by-products. The first national concerns on the dangers to life resulting from contamination of the environment were

highlighted with the passage of the National Environmental Policy Act (NEPA) in 1969. NEPA created the Environmental Protection Agency (EPA) in 1970 with a mandate to safeguard the nation's environment. Section 102 of NEPA outlined the specific requirements that any proposed action, such as new programs or projects, would have to meet in terms delineating the environmental impact and providing for public comment.

Unfortunately, in the past, no provisions were made for dumping of hazardous wastes. This severe problem was compounded by two facts: (1) the U.S. military is the nation's largest polluter and its activities have been covered up by its classified (secret) status, and (2) engineers and scientists found that the EPA-accepted method of containing most waste materials in the 1970s was flawed. Despite special linings and barriers to prevent the waste from seeping, leaks occurred after a few years of "containment". These leaks seeped into the water supplies of communities and wildlife habitats.

The nation was shocked in the 1970s when the story of Love Canal in upstate New York hit the media. Dumping started in the 1920s and accelerated after Hooker Chemical Company purchased the property in the 1940s. Engineers at the Hooker Chemical Company plant in California advised their superiors that the company was creating a serious public health problem by violating pollution limits and dumping toxic wastes. The Love Canal tragedy erupted a few years later when construction of a new school broke the clay seals that had held the chemicals inside. The highly toxic chemicals seeped through the soil toward the school and hundreds of homes surrounding the canal. Over 400 different chemicals were eventually identified, with some known to cause birth defects and cancer. Love Canal was found to be the "tip of the iceberg" — one of thousands of hazardous waste sites across the country.

From an environmental standpoint, Love Canal was not an isolated event. By 1978 the public had already witnessed dozens of environmental and public health disasters: a fire on the surface of the Cuyahoga River in Ohio, an enormous oil spill in Santa Barbara, the Kepone poisoning of the wells of Hopewell, Virginia, the inadvertent mixture of cancer-causing fire retardant with cattle feed in Michigan, the 17,000* containers of hazardous chemicals found in the "Valley of the Drums" near Louisville, the release

* This figure was found to be closer to 100,000 drums which had been dumped illegally at a farm and left to rot. The hazardous waste contents contaminated the soil and a local creek.

of a dioxin cloud over Seveso, Italy, and a massive cluster of birth defects among infants in a Woburn, Massachusetts neighborhood.

There are many forms of hazardous wastes, produced by industries such as manufacturers of chemicals, paints, petroleum products, and electrical equipment. In addition, the U.S. military and its contractors are major producers of toxic waste from nuclear weaponry research and development. In fact, all military installations have contaminated the environment with no regard for public health and safety.

The federal government has identified approximately 450 substances as hazardous to public health and the environment. For example, dioxin is one of the most toxic substances known. It covers a class of 75 chlorine-related compounds which are waste by-products from the manufacturing of chemicals and paper products. These toxic materials have been dumped in landfills and waterways, ending up in drinking water supply systems and food systems, including fish. Other chemicals that threaten health and the environment include polychlorinated biphenyls (PCBs). PCBs have been used to make paint, plastics, adhesives, and printing ink. They can cause cancer, birth defects, and skin diseases. Mercury is another industrial waste by-product that is poisonous — and yet has found its way into the food system from waterways.

In addition to the foregoing, there are many problems resulting from nuclear waste, including power plants and nuclear weaponry research and development. The latter is a “time bomb” because of the secret status of the research during the Cold War era, 1947–1992. There are untold thousands of sites on military bases and installations where tens of billions of gallons of toxic and radioactive wastes have been dumped into porous soil.

The discovery of Love Canal and scores of other dangerous chemical waste sites ignited fear and outrage across the country in the late 1970s. Galvanized into action — largely to remove immediate threats in communities such as Love Canal, New York — Congress in 1980 enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which quickly became known as Superfund. The law provided \$1.6 billion in cleanup funds and gave the EPA authority to force parties responsible for the contamination to conduct the cleanups or repay the federal government for its cleanup costs.

Superfund’s implementation has attracted almost continual criticism since its inception. In its first years, congressional investigations into allegations of mismanagement and political manipulation of the program led to

the resignation of EPA's administrator and the incarceration of the Superfund program's top official. In addition, the EPA Superfund was placed on the government's list of high-risk programs in 1992.⁷ Seventeen federal programs were so rated because of their vulnerability to waste, fraud, abuse, and mismanagement. Meanwhile, the number of highly toxic sites had grown to over 1300 in 1994, after spending over \$14 billion. The EPA Superfund Programs 1, 2, and 3 (1980-1995) are discussed as an IPQMS postmortem in Chapter 8.

In addition to the industrial dumping of hazardous wastes into the environment for many years, we now find that there are thousands of sites at military bases and installations contaminated by nuclear wastes from the Cold War era (1947–1992) research and development of nuclear bombs and weaponry.^{5,6}

Evidence of the on-going contamination is presented in the next section on the bomb factories. Additional evidence is documented in the IPQMS postmortems of the operation of the Trans-Alaska Pipeline System (Chapter 6), the EPA Superfund Programs 1 to 3 (Chapter 8), and the Hanford Nuclear Reservation (Chapter 9).

1.4 NUCLEAR WASTE CONTAMINATION

The age of nuclear energy, now over 50 years old, has given the world a great source of energy for both good and evil. On the one hand, it has helped to provide the electric power that does so much to make our lives more productive and enjoyable. On the other hand, it has terrorized us with the awful weapons it has created and the damages to public health and the environment.

Ranking high among its most frightening aspects are the waste materials that result from the production of nuclear energy and nuclear weaponry. Nuclear wastes loom as a danger to life and the environment because they are radioactive, emitting a radiation that can be deadly. Adding to their dangers is the fact that many require up to an astonishing 10,000 years before their radiation dwindles to the point where they are no longer able to harm.

The production of nuclear power and nuclear weaponry generates radioactive waste products, otherwise known as radwastes. If not properly stored, these wastes render our soil, air, and water supply vulnerable to radioactive contamination. The only secure means of disposal is shielding. Nuclear waste

needs to be stored far beyond human reach, where it can decay for the hundreds, even thousands, of years necessary for it to become harmless.

Unfortunately, a serious problem of radioactive contamination of both the workplace and the environment emerged in the late 1980s. This was the exposure of the “Cold War era” secret testing of human reaction to exposure to radiation and the poisoning of millions of people working in or living near nuclear weapons facilities. It began in 1947 and was kept secret for over 40 years. Meanwhile, nuclear waste disposal was taking place at 117 weapons factories, 16 principal and over 100 secondary, in 13 states. Contract management initially was the responsibility of the Atomic Energy Commission (AEC), one of the predecessors to the Department of Energy (DOE). DOE now has the responsibility for the huge task of cleaning up these sites.⁸

The bomb factories highlight the absolute disregard for public health, worker safety, human dignity, and the environment. Indeed, they represent a total collapse of ethics and accountability in our government and the defense contractors as evidenced by their ignoring the professional engineers, scientists, and managers who were trying to “blow the whistle”.⁹ The media first made a large-scale exposure of the nuclear weaponry research and development at the 16 major sites in late 1988. Whistleblowers were beginning to expose the innumerable health, safety, security, and other violations at all the bomb factory sites in 1986. Plant workers, their families, and their communities have been knowingly exposed to unacceptable levels of radioactive emissions and wastes since 1947. However, it took the Chernobyl nuclear plant disaster of 1986 in Russia to trigger U.S. media to listen to the whistleblowers.

The bomb factories represent an unfortunate symbol of collusion between the military and defense contractors that President Eisenhower warned the nation about in his farewell speech, January 1961. He was deeply concerned about the secret power of a military-industrial complex, one that would result in excessive deception, corruption, and fraud. Unfortunately, his advice was not followed, and the collusion between the federal government and big business, especially defense contractors and the oil industry, resulted in complete disregard for laws and regulations designed to protect public health and safety and the environment. The whistleblowers, or ethical resisters, are a relatively new group who are concerned about the lack of accountability in government and industry today.

The whistleblowers have been harassed, both mentally and sexually, by their superiors. They have also been rebuked by the federal government,

including the Nuclear Regulatory Commission and members of Congress. They now have an ally in the Government Accountability Project (GAP), a nonprofit, public interest organization based in Washington, D.C.^{9,10} GAP provides legal and advocacy assistance to concerned citizens who witness dangerous, illegal or environmentally unsound practices in their workplaces and communities and choose to “blow the whistle”. Since its founding in 1977, GAP has helped hundreds of public and private employees and grass-roots organizations expose threats to public health and safety and the environment.

The nuclear weaponry sites have contaminated billions of gallons of water and millions of tons of soil with wastes from the bomb building plants. Estimated costs of cleanup range from \$250 to \$300 billion over the next 20 to 30 years.^{6,11} Goodman and Ignacio show how a new methodology they developed with an international team, the Integrated Planning and Quality Management System (IPQMS), can be used to clean up these sites efficiently. The IPQMS, when properly introduced and implemented, results in accountability, cost effectiveness, and quality.

The postmortem shows that waste, fraud, and mismanagement in the cleanup of the Hanford Nuclear Reservation site are rampant. Over \$7.5 billion were spent between 1991 and 1996, with \$2.5 billion lost because of *no accountability*. Meanwhile, the nuclear contamination continues to move into the groundwater which flows into the Columbia River. Yet, the whistleblowers continue to be ignored by Westinghouse Hanford and the DOE.¹²

1.5 CONTAMINATION OF MILITARY BASES

In addition to the bomb factory sites, there are over 9700 military installations and former defense properties in all 50 states. In 1988, the Department of Defense (DoD) began to examine ways to achieve savings by realigning and closing military bases that were costly to operate and no longer needed to meet changing requirements. In December of that year, the Commission on Base Realignment and Closure (BRAC 88) recommended that 86 military installations be closed and 59 others be partially closed, expanded, or reduced by the relocation of military units.¹³

Because the commission was concerned primarily with ensuring that military requirements be met, such factors as the environmental impact of closing bases received less emphasis in its deliberations. The commission concluded, for instance, that it did not need to consider the cost of cleaning

up hazardous wastes because, under current law, the government would have to clean up the properties in any event. Consequently, in considering which bases to close, the commission had only preliminary estimates of the extent and nature of environmental contamination.

Until legislation governing the handling and disposal of hazardous waste took effect during the past decade, requirements for managing the disposal of waste on military bases were not nearly as stringent as they are today. Consequently, environmental contamination is widespread, in some cases constituting a significant potential threat to public health and safety.

On the bases scheduled for BRAC 88 closings, a wide variety of sources of pollution exists: landfills, fuel and paint dumps, buried munitions, PCB transformers, asbestos, radon, groundwater contamination, and underground storage tanks that have developed leaks. Cleaning up buried munitions and groundwater contamination are among the most difficult, time consuming, and costly of these problems. Among the BRAC 88 bases, DoD had identified seven with buried munitions and at least 10 instances of groundwater contamination. The latter may also exist at numerous additional sites — for example, landfills and underground storage tanks — but final determinations have not yet been made. Other types of cleanup, such as removing PCB transformers, can be relatively simple and require only a short time to complete.¹³

The Congressional Budget Office (CBO) estimated there might be over 20,000 contaminated sites on the 9700 military installations in 1994. Again, it is emphasized that these sites are in addition to the Cold War era nuclear weaponry research and development sites, such as the Hanford Nuclear Reservation. A small number of these sites have been placed on the EPA Superfund National Priority List (NPL).

1.6 CONSTRUCTION INDUSTRY ISSUES

The construction industry is the nation's second largest industry (behind health care) and also the most fragmented and among the least progressive. In recent years it has been required to build facilities that are more and more complex, utilizing methods that are largely unchanged. At the same time, there has been a steady erosion in quality and productivity of the industry. This negative impact on the cost of every office building, water supply system, waste disposal system, or power plant that is built affects the price that must be charged for the services provided by those facilities.

One major reason that construction is comparatively inefficient is in its fragmentation and consequent lack of teamwork. It is a \$600+ billion a year activity (1995) involving close to one million contractors, over 70 national contractor associations,* more than 10,000 local and national labor organizations, and over 6 million people, including professionals and skilled and semiskilled workers. Despite the capabilities of the larger and more progressive contractors, and despite the sophistication of many clients for construction, too much of the industry remains mired in the past. Construction effectiveness starts with the owners, and they, along with governmental regulators of the construction industry, are part of the restraint. An adversarial relationship often exists, breeding suspicion and lack of cooperation among key participants.

In parallel with decreasing construction efficiency, construction's share of gross national product** has been declining. Historically, it has run about 10 percent of GNP, but since 1975 that share has dropped several percent. Currently, it is about 8 percent of GNP. Keys to upgrading the industry are cooperation and communication between and among the principal parties — owners, planners, designers, and contractors. There is a great need for organized knowledge and exchange of information. Meaningful research must involve realistic data gathered from current practice. In contrast to most areas of engineering, it is difficult to model projects in a laboratory. Data are scattered among thousands of projects, involving a multitude of owners, contractors, and other parties.

Construction has long been recognized as a fertile field for research and significant academic and practical contributions. Only recently, however, has adequate attention been given to the needs for funds to support continuing studies in the field. The Business Roundtable completed a multi-million dollar study in 1982 which identified many research needs.¹⁴ The President's Private Sector Survey on Cost Control (Grace Commission) identified waste and mismanagement in public works projects as part of its comprehensive study of the federal government in 1982 and 1983.¹⁵ The East-West Center conducted autopsies on 30 projects in nine countries from 1977 to 1982 to

* The largest is the Associated General Contractors of America (AGC), with 32,500 member firms and 102 chapters nationwide.

** Gross National Product (GNP) is the sum of the country's total output of goods and services. GNP used here is based on current dollars. GNP in 1995 was ±\$7.35 trillion.

better understand why projects fail (run over schedule or budget, *or* collapse), and how to improve productivity and quality.¹

The conclusions drawn from the various studies of the construction industry, including autopsies or postmortems of projects, clearly demonstrate a common problem — fragmentation. Thus, the need for integrating planning, design, construction, and management has been reinforced. This will require teamwork, exchange of information, and establishing a data base to provide insights and lessons from past mistakes. Teamwork must include the principal parties involved in the industry: owner, design professional, and contractor.

1.7 TWO MAJOR PROGRAMS ADDRESSING THE ISSUES

1.7.1 THE CONSTRUCTION INDUSTRY INSTITUTE (CII)

The Business Roundtable study resulted in the creation of a national forum called the Construction Industry Institute (CII). The CII was established at the University of Texas in Austin in 1983. It is supported by large industrial firms and construction companies, including design-build firms.

The CII is an innovative concept for research and development in construction. It is intended to provide a resource to help bring together the fragmented industry in areas of common problems and needs. It allows owners, designers, contractors, universities, and other organizations involved in construction to cooperate in areas of common concerns and interests.¹⁶ The initial objectives of the institute were:

- To develop into a principal national forum for issues related to the cost effectiveness of the construction industry.
- To bring together experienced management, technical personnel, and their companies who share a broad view of the construction industry, and are willing to participate and pool their expertise to improve it.
- To identify important issues which impact the cost effectiveness of the construction industry, support and direct research, prepare and

offer recommendations, and define the measurable results expected from implementation.

- To disseminate both credible information of value and state-of-the-art knowledge to the construction industry through appropriate vehicles of communication and education.
- To establish and maintain appropriate liaison with other organizations active on construction industry issues of mutual interest.

Sustaining membership in the CII is open to companies in the U.S. that have a significant involvement in the U.S. construction industry as a construction user, constructor, or engineer. Sustaining membership in the CII requires an annual membership fee of \$36,000 plus a commitment to support the activities of the CII through participation in the Board of Advisors and the Advisory Committees. The membership objective is to have no less than 40 percent representation by either the construction users or the contractors/engineers group. There were approximately 100 members in 1996.

The CII has made much progress in construction productivity in large projects involving the charter members. Unfortunately, there has been little or no impact on the majority of construction projects in the U.S. The CII has made significant contributions to education and practice through an extensive series of research reports and video tapes in areas of contracts, implementation, materials, management, partnering, and quality of management. Again, the audience has been limited to primarily the charter members, who represent a small percentage of the overall industry.

1.7.2 THE AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

The American Society of Civil Engineers (ASCE) convened a series of meetings with leaders of the design and construction industry in 1983–1985 to discuss efforts to achieve quality in the constructed project. The principal recommendation was that ASCE should develop and publish “a comprehensive and authoritative guide on quality in design and construction that would clearly define roles and responsibilities of the participants in the process.” ASCE recruited approximately 40 authors and 70 reviewers to produce Volume 1 of a manual titled *Quality in the Constructed Project: A Guide for Owners, Designers and Constructors*.¹⁷

The manual encourages teamwork among the principal parties of owner, design professional, and constructor. Unfortunately, there is lack of an inte-

grative force in the manual to ensure the necessary teamwork is achieved. Another major gap is lack of attention to the importance of feasibility studies to the design and construction phases. Thus, the barriers in design and construction that account for fragmentation still exist.

In 1987, members of ASCE tackled the question “What will the probable state of civil engineering be in the 21st century?” ASCE concluded that “meeting the challenges of the civil engineering profession in the 21st century will require imaginative and creative research, some of it in totally new fields.” The members recommended a “coordinated national research strategy...,” which at the time was nonexistent, and requested that ASCE “...develop and execute a program of basic and applied studies, and demonstration projects.”

In May 1988, the ASCE Task Committee on Implementation of a Civil Engineering Research Foundation (CERF) reported on its activities to the ASCE Board of Direction, which included the establishment of the corporate entity now known as CERF and the Committee’s recommendations leading to the start-up of the Foundation in 1989.

The mission of CERF is to unify the civil engineering profession through research and innovation. It received basic support from ASCE, with major support from cooperating organizations through a partnership effort in joint research projects. Collaboration to date has been significant with federal departments and agencies. For example, the U.S. Environmental Protection Agency (EPA) is now collaborating with CERF to evaluate a broad range of new environmental technologies for pollution avoidance and remediation/restoration.

Another example is the Highway Innovative Technology Evaluation Center (HITEC). HITEC was established in 1993 in conjunction with the Federal Highway Administration to help move highway innovation into practice more quickly.

These joint efforts are intended to evaluate new technologies and then move them into practice. However, CERF does not address issues of accountability, cost effectiveness, and quality.

In summary, the overall picture of the status of the nation’s infrastructure and environment is not good. Many circumstances have converged to create current infrastructure problems. The most serious are:

- The high cost of construction because of fragmentation of the industry, which results in lack of teamwork and accountability.
- Shifting responsibilities: the Reagan administration shifted infrastructure maintenance and repair from federal to state budgets. In many cases, state and local treasuries were unable to foot the bill. In addition, the Highway and Airport Trust Funds are broke.¹⁸
- Deferred maintenance: elected officials, faced with the choice of erecting new structures or systems, or repairing old ones, tend to leave the repairs to their successors. So do their successors, leaving bigger and bigger problems.
- Funding allocations: owing to the way federal funds have been distributed, many states and municipalities have found it cheaper to “build new” than “fix old.” Highway funds, for example, are made available for construction, not earmarked for repairs.
- Increased loadings: structures built to take specific loads now must take much more, with trucks having doubled and even tripled in weight.
- Timing: the numerous public works projects of 40 to 50 years ago are “coming due,” revealing any mistakes embedded in their construction (such as the bridges and overpasses in the California earthquakes of 1971, 1989, and 1993).

Rebuild America, a broad-based coalition of organizations concerned with adequate infrastructure investment, was established in 1987.³ It lobbies for the release of federal trust funds for needed transportation and public building improvements, including school buildings. Unfortunately, they do not understand that all the Federal Trust Funds are broke. Rebuild America includes city, county, state, and national officials, as well as other public leaders whose job it is to maintain, inspect, and plan for the building and rebuilding of our public facilities. These professionals are supported by engineers, builders, financiers, contractors, and architects concerned about the dire national consequences of substandard infrastructure.

The rise and fall of a civilization ultimately is linked to its ability to feed and shelter its people and to defend itself. These capabilities depend on the vitality of its infrastructure — the underlying, nearly imperceptible foundation of a society’s wealth and quality of life. A civilization that stops investing

in its infrastructure takes the first steps toward decline. As the infrastructure decays, society slowly becomes paralyzed by its inability to transport people and food, provide clean air and water, control disease, and conduct commerce.

In the last century, the U.S. invested heavily in its infrastructure — from canals to fiber optic systems, from fresh water to interstate highways and rapid mass transit systems. But this infrastructure now is deteriorating due to excessive demand, misuse, and neglect. The fragility of these systems and the staggering losses their failure will incur was graphically illustrated by the Chicago flood in April 1992, Hurricane Andrew in August 1992, and a minor telephone outage in New York in September 1991 that shut down three major airports. Several studies indicate that the current decline in U.S. productivity and its increasing deficit are partly the result of a deteriorating, inadequate infrastructure.¹⁹

The Rebuild America Coalition requires assistance to awaken Congress and the White House to the vital need for their actions. The National Science Foundation (NSF) will sharpen the focus on this urgency by establishing a national Institute for Civil Infrastructure Systems (ICIS) in late 1997.²⁰ Unfortunately, neither the Rebuild America Coalition nor the NSF initiative addresses the construction industry issues. The IPQMS, when properly introduced and implemented, would result in the necessary teamwork essential for success.

1.8 THE NEED TO TEACH TEAMWORK

To be successful, rebuilding America's infrastructure and cleaning up the environment must be undertaken on a team basis. Of equal importance, this task must include provision for accountability. Experience with over 20 years studying budget overruns and other costly mistakes in both public and private projects points to common problems of fragmentation in planning, design, and implementation. To illustrate these problems, consider the following cases:

- The Trans-Alaska Pipeline System (TAPS) Part One (1968–1977)
Budget overrun from \$900 million to \$8+ billion.
Constant design changes during construction.

- \$1.5 billion lost to waste, fraud, and mismanagement.
 - Basic problems related to lack of adequate feasibility studies.
- TAPS Part Two: Operation (1978–1996)
 - Constant violation of federal and state laws regarding worker health and safety and polluting the environment.
 - Sexual and mental harassment of whistleblowers by management.
 - The largest oil spill in U.S. history, compounded by lack of a viable response system.
- State of Washington Five Nuclear Power Plants (1968–1992)
 - Original estimate of \$5.7 billion ballooned to over \$24 billion in 1984, and growing.
 - State defaulted on \$2.25 billion in municipal bonds in 1982 due to waste, fraud, and mismanagement.
 - Two power plants canceled in 1982 and two were “shelved” after construction was more than 65 percent completed.
 - Escalation of construction costs in one state causing an economic depression in neighboring states.
- Washington, D.C. Metro System (1968–1995)
 - Original estimates of \$1 billion exceeded \$7+ billion in 1995 with only 81 miles and 70 stations completed out of a projected 102 miles and 83 stations; another \$2.6+ billion needed.
 - Large budget overruns caused by inadequate planning regarding the effect of tunneling on adjacent structures and resulting litigation.
 - Lack of competence in the management of design and construction.
- Environmental Protection Agency’s Superfund Programs 1, 2, and 3 (1980–1995)
 - Only 90 toxic waste sites cleaned up after 14 years and \$14+ billion expended (projections estimated 300+ sites would be completed).
 - Lack of integration of planning, design, and implementation.
 - No attempt made to establish a data base after Program No. 1 in 1985.
 - The U.S. General Accounting Office (GAO) reports on waste, fraud, and mismanagement ignored by Congress and the White House.
 - Lack of continuity in leadership of the EPA — use of political

appointees.

Nobody in the entire federal government is accountable — this violates the Constitution regarding the spending of public money.

- **Spacecraft Challenger Disaster (January 28, 1986)**
Explosion 73.213 seconds into launch, killing six astronauts and one school teacher.
O-Ring pressure seals in the right solid rocket motor failed, permitting the escape of highly pressurized rocket fuel.
The recommended escape system for such an emergency had been rejected in 1972 as too costly (\$300 million).
Repeated warnings by engineers of O-ring problems (charring and erosion) since 1979 ignored by Morton Thiokol and National Aeronautics and Space Administration (NASA) managers.
- **Hanford Nuclear Reservation, Richland, WA (1950–1996)**
Management operating the facility for over 40 years without regard for environmental, health, or safety requirements.
Department of Energy (DOE) and its predecessor agencies knowingly exposed tens of thousands of bomb-plant workers to conditions that resulted in injury, health problems, and death. In addition, most of these workers and neighboring communities have been exposed to harmful levels of radioactivity.
High-level nuclear wastes dumped onto the desert floor and into the Columbia River.
No oversight by federal agencies or members of Congress. Indeed, contractors such as Westinghouse Hanford and its predecessor, Rockwell International, are reimbursed by the DOE for legal expenses fighting the whistleblowers.
Deliberate and illegal destruction of documents showing waste storage problems, leaks, and other dangerous conditions.
Waste, fraud, and mismanagement rampant in clean up of contaminated sites. Over \$7 billion spent since 1991, with \$2+ billion lost to waste and fraud.
Whistleblowers ignored by management and the U.S. government in all of the above.

The foregoing problems can be avoided by using the integrated planning and quality management system (IPQMS). Chapter 2 introduces the IPQMS.

The authors propose a 10-year program in Chapter 10 to rebuild the infrastructure and clean up the environment. The program would be a federal–state government partnership costing \$35 billion a year. It would be planned, designed, and implemented in the IPQMS framework to ensure

accountability, cost effectiveness, and quality. The money would come from the \$65+ billion in Corporate Welfare.

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